Light and Lighting

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Lighting in the Mines

THE production of coal is one of the outstanding "headaches" of the age. Mining is subject to control by regulation to a far greater extent than any other industry. New plans for its reorganisation are continually being offered. Meantime the problem of getting the coal remains.

Mr. C. S. Chubb's recent paper before the I.E.S. Newcastle Centre (see pp. 47 and 48) reminds us that the lighting problems of the coal mining industry are also of outstanding difficulty. This is one of those rare cases in which no assistance is derived from daylight. Everything must be done by artificial light. In very many "fiery" mines safety hand-lamps, furnishing, on the average, little more than 3/4 candle, form the sole permissible means of illumination at the coal face.

In industry generally 6 ft.c. is now considered the minimum working illumination; 10 or even 20 ft.c. are not unusual. Yet at the coal face a general illumination of 0.25 or even 0.1 ft.c. would be received with gratitude.

Finally, conditions of maintenance, owing to the universal presence of coal dust, are probably more severe than in any other field of work.

Here, surely, is a sphere for the efforts of the illuminating engineer!

American I.E.S. Board of Fellows

The establishment of Fellowship by the American I.E.S. has been under consideration for some time, and in *Illuminating Engineering* (February, 1945) a list of the first ten Fellows elected is given. This list naturally consists of very eminent members of the American Society, most of whom (like Dr. E. C. Crittenden, Mr. S. G. Hibben, and D. M. Luckiesh) are well known by repute to British illuminating engineers. It is interesting to observe that the qualifications are somewhat stiffer than those adopted by the British Society. The minimum age is 32 (as compared with 28); the period of membership is three years (as compared with two); and, in addition to a period of five years in responsible work (the same), an applicant should, in the ordinary way, have been engaged in illuminating engineering for at least ten years. There is also a requirement that a Fellow "shall have made some valuabe contribution to the technical activities of the Society, and to the science and art of illumination or to scientific fields related directly thereto"—a condition which the I.E.S. in this country does not at present impose, though doubtless achievements in this field would be taken into consideration. A Board of Fellows, selected from the ten original members elected to the grade of Fellow, has now been appointed.

End of the Black-Out

The announcement of the removal of "black out" regulations, from April 23 onwards (with the exception of coastal areas) hardly came as a surprise to the public, following the alleviation already granted—which, indeed, robbed it of much of the dramatic effect anticipated in the days when conditions were at their worst. Although the removal of penalties for leaving lighted windows unscreened is a relief, householders will doubtless continue to draw their curtains when night falls and—owing to deficiencies in cash, coupons, or labour—may continue to use existing black-out material for some time to come. Lack of labour and apparatus may also limit further advances in the modified street lighting already in operation. Gradual improvement from now onwards may be expected, though nothing very new or spectacular can be anticipated at present. Considerations of fuel saving may also play some part (limitations of street lighting are being practised during the period of Double Summer Time). It is to be hoped, however, that the coming winter will see the restoration of shop-window lighting and at least partial revival of illuminated signs—though, here, again, the limit on expenditure (£10 per annum) will apparently act as a brake on the reinstatement of the many signs suffering from enforced neglect or enemy action.

Forthcoming I.E.S. Meetings

(Provisional List)

SESSIONAL MEETINGS IN LONDON

1945.

May 15th. Annual General Meeting, followed by an Address by DR. W. R. G. ATKINS, O.B.E., F.R.S., on **Daylight and Its Penetration Into Sea Water.** *(In the Lecture Theatre of the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W.1.)* **5.30 p.m.**

MEETINGS OF CENTRES AND GROUPS

1945.

May 1st. MR. F. L. ATKIN on **Infra Red Drying.** *(In the Electricity Corporation Department Demonstration Theatre, Charles Street, Leicester.)* **6 p.m.**

May 4th. Annual General Meeting of Bath and Bristol Centre, followed by an Address by MR. W. IMRIE SMITH on **Special Industrial Lighting.** *(In the Pump Rooms, Bath.)* **7 p.m.**

May 8th. Annual General Meeting of Sheffield Centre. Address by The President (MR. E. STROUD.) *(At the Nether Chapel, Norfolk Street, Sheffield.)* **6 p.m.**

May 10th. Annual General Meeting of Cardiff Centre. *(In the Cardiff Corporation Demonstration Centre, The Hayes, Cardiff.)* **3.15 p.m.**

May 29th. MR. E. P. MAWSON on **Lighting and Leisure.** *(In the Electricity Showrooms, Market Street, Huddersfield.)* **7 p.m.**

June 5th. DR. A. B. WHITWORTH on **Electric Lamp Manufacture.** *(In the Electricity Department Demonstration Theatre, Charles Street, Leicester.)* **6 p.m.**

The Place of Science in the Art of Lighting

The repetition of their joint talk on the above subject by Mr. Alistair MacDonald and Mr. R. O. Ackerley in Edinburgh, on March 28, was a very successful event. The I.E.S. Edinburgh Group are to be congratulated on their enterprise in arranging this joint meeting with the Edinburgh Architectural Association, and the two authors deserve the cordial thanks of the Society for making this journey to the North.

As in London, the speakers did not give formal addresses, but joined in a species of dialogue, which was illustrated by some effective exhibits, such as Mr. Ackerley's demonstration of the lighting of cornices, designed to show the need for co-operation between the illuminating engineer and the architect. A vote of thanks was moved by Professor M. G. Say and the Chairman, Mr. J. Wilson Paterson (Edinburgh Chapter of the R.I.S.A.), who expressed the hope that other joint meetings would be arranged in the future. This hope was echoed by Councillor J. B. Mackenzie. The final meeting of the I.E.S. Edinburgh Group on April 27), was allotted to a "Brains Trust" meeting.

Personal Notes

The degree of Ph.D. (External) has been awarded by the University of London to Mr. J. N. Aldington for a thesis on "The High Current Density Mercury Vapour Arc." Mr. Aldington, an I.E.S. Fellow, is Head of the laboratories of Siemens Electric Lamps and Supplies, Ltd., at Preston. He has done much research on electric lamps (both filament and discharge), some of which was conveyed in his recent paper to the Society on "Bright Light Sources."

Mr. M. C. Hughes has been elected honorary assistant secretary of the I.E.S. Cardiff Centre.

(Secretaries of Centres and Groups are requested to send in particulars of any changes in programmes, mentioning subject, author, place, date and time of meeting; summaries of proceedings at meetings (which should not exceed about 250-500 words) and any other local news are also welcome.)

Electric Lighting Installations for Building Interiors

Summary of a paper read by Mr. R. O. Ackerley before the Installations Section of the Institution of Electrical Engineers on April 12th, 1945.

There was an excellent attendance, including a number of leading I.E.S. members, at the meeting of the Installations Section of the Institution of Electrical Engineers on April 12, when Mr. R. O. Ackerley's paper on "Some Factors Affecting the Design of Electric Lighting Installations for Building Interiors" was read.

In introducing his subject Mr. Ackerley drew attention to the variety of conditions of lighting made possible by recent advances in electrical illuminants; new possibilities, however, brought with them new problems, some of merely academic interest 30 years ago, but now questions of daily importance.

The Eye the Judge

It is not incumbent upon every electrical installation engineer to be an expert illuminating engineer. He is, however, expected by the public to be able to advise on lighting methods. There is a wealth of information available, but illumination design is far from being an exact science. There are, in fact, three partners in vision—the light, the eye, and the object lit—and only the first of these can be scientifically controlled. The final judge of the lighting is not the photometer or the arithmetic but the eye. The scene must be made to appear "right" to the observer.

The Lighting Problem

After some further preliminary remarks recalling the chief factors involved and the characteristics of the eye Mr. Ackerley proceeded to an analysis of "The Lighting Problem," aided by an informative chart, which appeared continuously upon the main screen, whilst at intervals lantern slides dealing with derived topics were shown on a subsidiary one.

From the main title, "The Lighting Problem," spring two sets of considerations: firstly, "general" (function of room, structural features, decoration, etc.), and, secondly, "special," which again are partly physical (texture of material, etc.), and partly visual. With these is linked the Method of Lighting, which is again subdivided into general and special items, and in addition there are numerous factors affecting illumination, linked up and ultimately leading to the two final items to be determined, namely, the number, wattage, and position of fittings for (a) general lighting and (b) local lighting.

Analysis of the Task.

Mr. Ackerley introduced various examples to illustrate what is involved in "special objects of regard," contrasting the performance of the automatic stitcher with that of the inspector who has to see and examine the results of this work. A full analysis of the job is needed in order to determine the kind of lighting necessary. The nature of the problems to be studied was further illustrated by two films, one showing the process of threading a needle the other work at the lathe, for which the local lighting was adjusted to get the best result.

Local and General Lighting

It was pointed out that intermediate conditions between general and local lighting exist, though when very high illuminations are needed the latter, aided by the former, becomes necessary. "Angle Lighting" is also valuable on occasion in order to give good illumination on vertical surfaces, to avoid shadows of overhead obstructions, and to create deliberate shadows in order to emphasise texture or reveal faults. The average general illumination should, as

a rule, not be less than one tenth of the local illumination, but when very high local illuminations (e.g., 150 ft.c.) are used a smaller proportion may be satisfactory. This proposed limit to the ratio between local and general illumination applies primarily to industrial lighting; in shops and similar places where a high local illumination is introduced to give emphasis or to draw the eye to a selected article, different considerations may apply.

The I.E.S. Code

Mr. Ackerley then passed on to the discussion of values of illumination for various purposes, quoting from the I.E.S. Code and explaining how the requisite value is determined from such factors as the size of the detail to be seen, the contrast between the object and its surroundings, the reflection factor of the object, the effect of motion of the object, and the duration of the task. In this connection he showed an ingenious chart prepared by Mr. H. C. Weston and designed to enable the illumination for any task to be roughly determined, once the size of object, contrast and reflection factor are known.

Brightness of Fittings

Turning next to fittings the lecturer set out a classification into three types (a) direct lighting fittings giving not less than 70 per cent. of the light in the lower hemisphere, (b) general diffusing fittings, giving less than 70 per cent. and more than 30 per cent. in the lower hemisphere, and (c) indirect lighting fittings giving over 70 per cent. of the light in the upper hemisphere. Fittings may be further sub-divided according to the angle over which the bulk of the light is distributed, on which spacing/height ratios are based. A reminder was given, however, that the spacing/height ratios found in makers' catalogues are usually the *maximum* permissible for uniformity; there is often substantial advantage in adopting closer spacing.

The maximum brightness of a fitting, it is now recognised, should bear a definite relation to the value of illumination provided. In this connection Mr. Ackerley suggested, as a guide, the accompanying table.

Recommended Values for Surface Brightness of Fittings (Candles per sq. in.)

(Maximum within an angle of the eye (5 ft. above the floor) of 110° from the downward vertical.)

Illumination on Horizontal Plane.	Height of Fittings.	
(Ft.c.)	Below 8 ft. from floor.	Between 8 ft. and 16 ft. from floor.
Up to 10... ...	2½	5
Above 10 ...	5	10

High brightness sources are the more liable to cause glare. On the other hand the smaller the source the greater are the possibilities of light control, and the greater the brightness of the source the smaller the reflector required to project any required amount of light. High brightness sources can be transformed into large area small brightness sources by surrounding the lamp with appropriate diffusing media; but the converse process is impossible.

The Future

After an explanation of the application of utilisation coefficient in determining the nature and number of lamps to afford a given illumination, Mr. Ackerley gave some data in regard to fluorescent lamps, emphasising their familiar advantages and drawbacks, and concluded by a brief discussion of future developments. Amongst the points mentioned were the importance of "task analysis" and of methods of making the task easier (e.g., by decreasing the size of detail to be seen, improving contrast or reflection factor, etc.), and the tendency towards still higher values of illumination. New colours and new ratings of fluorescent lamps (shorter lengths and lower wattages are expected) will increase their opportunities. They are likely to play an important part in the future, notably as a means of supplementing daylight.

Measurement of the Photometric Properties of the Upper Atmosphere

The agreeable joint meeting with the Royal Meteorological Society at the Imperial College of Science (London), on March 21, well illustrated the wide field of action of the I.E.S.

In his paper on "Measurement of the Photometric Properties of the Atmosphere" Mr. J. M. Waldram had a fascinating story to tell of experiments conducted at altitudes up to 30,000 ft., under conditions that were often most difficult and at times decidedly hazardous. The work was undertaken by a sub-committee of the Civil Defence Committee (Ministry of Home Security), under the chairmanship of Mr. Percy Good.

Amongst the problems of visibility that have arisen in connection with civil defence and Service matters are visibility of the ground from the air, air to air visibility, camouflage, searchlights and flares used in various ways, etc. All are concerned with changeable atmospheric effects, of which little was known and which could be studied under practical conditions only with great difficulty. It was, however, found possible to tackle these problems by a combination of laboratory experiment on a reduced scale, aided by calculation and verified by occasional full-scale tests.

The experiments were made at altitudes up to 30,000 ft. in clean air and up to 3,000 ft. in industrial atmospheres. Mr. Waldram explained—and illustrated by some pleasing experiments—the double effect of the atmosphere in diminishing light passing through it, but at the same time producing a "veil of light" owing to scattering. This effect could be estimated in terms of the scattering coefficient. It was also necessary to study the distribution by means of a "polar scatter index." Complications are introduced by the smoky nature of industrial atmospheres, which may involve considerable absorption of light.

Mr. Waldram described and illustrated the special photometric apparatus designed for this work, the polar nephelometer. The difficulty of operating a telephotometer in a vibrating aeroplane can well be imagined; a plan was eventually adopted permitting one observer to keep the line of sight trained, whilst another made the actual measurements. Air ground brightness has been measured by studying the apparent brightness of a white sheet on the ground. The brightness of searchlight beams was also examined, and a "low brightness photometer" designed with which measurements could be made down to a few millionths of an equivalent foot-candle. The paper described four series of experiments in clean air and others in industrial atmospheres. The results, assembled in a series of graphs, are of extreme interest to experts.

In the discussion Sir George Simpson paid tribute to the very valuable work that had been accomplished, and especially to the new understanding of "visibility" which it made possible, and Dr. Paterson and Mr. Good likewise commented on the patient skill with which these changeable and difficult atmospheric conditions had been studied. The latter, also, in referring to the origin of this work, recalled Sir Reginald Stradling's sympathetic reception of the Society's offer of the expert services of its members at the outbreak of war. As an illustration of the value of this work to meteorologists Mr. Good recalled their prediction that a cloud of a certain size would come over in three hours' time—which it did.

The full text of the paper is to appear in the I.E.S. Transactions in due course.

Some Problems in Mine Lighting

(Proceedings at a Joint Meeting of the I.E.S. Newcastle Centre and the Association of Mining, Electrical and Mechanical Engineers; held in Newcastle-upon-Tyne on March 7th.)

There was an audience of about 130 at the meeting in Newcastle on March 7, when Mr. C. S. Chubb's paper, entitled "Some Problems in Mine Lighting," gave rise to a keen discussion.

Mr. Chubb, who is associated with Cardiff University and an expert on this problem, pointed out the extraordinary difficulties involved in the lighting of coal mines. In the first place there is here no help at all from daylight; it is only by aid of artificial light that anything can be rendered visible.

Effect of Coal Dust

In addition to the danger of explosion (which in some cases severely limits the nature of the lighting possible) you have the ever-present problem of dust. The effect on fittings is such that cleaning at least once every shift is expedient. So-called dust-proof fittings, being difficult to clean, may prove a drawback unless they are *really* dust-proof. The presence of dust in the atmosphere also results in great absorption of light, so that sources of light should be brought as close to the work as possible. Continual deposits of dust also tend to diminish the results of efforts to lighten surroundings by whitewashing, etc.—though these are certainly beneficial.

Portable Lamps

The original source of light, the "hand" or "portable" lamp, has made progress but still affords only a very poor illumination on the coal face. In fiery mines only oil and electric "safety" lamps can be used. By constant improvement the light yielded by them has been increased to about 0.75 m.s.c.p.—still less than that of the domestic candle. With cap lamps the candlepower within the limited range of vision is increased, and in naked light (relatively safe) mines carbide lamps giving 4 to 6 c.p. may be used. There is also, where compressed air supply is available, a lamp fed by electricity derived from a portable generator driven by compressed air.

Standard miner's lamps are, however, still in use in the majority of cases, and the present lighting available to the coal-face worker is deplorably insufficient.

Miners' Nystagmus

Cases of miners' nystagmus each year total more than all the other cases of accident and disease. The Miners' Nystagmus Committee of the Medical Research Council, in their Third Report, recommended an illumination at the coal face of not less than 0.25 ft.c. if nystagmus was to be eliminated, and it was suggested that if even 0.1 ft.c. over the immediate working area could be constantly maintained the incidence of the disease would be materially diminished.

This value may well appear incredibly low to illuminating engineers, but it was recognised by the Committee that even 0.02 ft.c. was not likely to be realised with the lamps in use.

Coal-face Lighting

Lighting at the coal face is limited by other factors, the confined space and low head room, and the fact that the means of lighting must be continually moved forward as the face advances. This, in itself, makes mains lighting at the coal face difficult, and though a number of experimental installations have been made, none has made enough improvement to warrant its continuance.

In addition to these technical difficulties it must be remembered that mining is subject to control by regulation to a far greater extent than any other industry. The more general case in British mines is where, owing to the danger of explosion of firedamp, lighting is restricted to the use of safety lamps. There are some coal mines in which this danger does not arise (so-called "naked light mines") and where there are no special lighting restrictions

though the electrical regulations of the coal mines still apply. (These restrict types of electrical supply and prescribe an alternative source of light in all places where failure might cause danger.) Where mains lighting is permitted the pressure is limited to 125 volts. This precludes the use of electrical discharge lamps. Owing to the low roof and narrowness of passages lamps must in general be mounted not more than 11 yards apart, so as to avoid ill effects of glare. Lamps of moderate power, up to 60 watts, are usual in such circumstances.

A special opportunity for the use of discharge lamps, either mercury or sodium, for surface lighting does, however, exist, and Mr. Chubb presented figures governing the period for which such lamps should be kept in use. He also referred to the special utility of mercury vapour e.d. lamps for coal picking, where the colour aids the detection of dross. In the author's experience the illumination need not exceed 15 ft.c. and an allowance of about 20 watts per foot length of belt.

Thickness of Seams

In the discussion many interesting technical points were raised. Colonel Daniel reported more hopeful experience of nystagmus, which he attributed to the fact that they used a great number of cap lamps. Mr. Ogle also referred to their frequent use in mines in Pennsylvania and to the adoption of flood lights on trailing cables. Where there was a very thick seam—8 ft. to 9 ft.—the lighting was mounted on the machine itself. Other speakers, however, pointed out how much depended on faces, in which connection Colonel Daniel recalled the Durham miner who told the Welsh miner that the bacon in South Wales was as thick as the coal seams in Durham! There was general agreement that regulations made coal-face lighting difficult, and Mr. Chubb remarked that one of its greatest drawbacks was the hoards of inspectors it produced. One speaker reported a method of working discharge lamps on 100-volt circuits, but there seemed some doubt whether this was not effected by means of a transformer.

Absorption of Light

It was calculated from Mr. Chubb's data that in some situations the absorption of light must be 70 per cent.; was it possible for people to live in such circumstances? In his reply Mr. Chubb explained that it was only in exceptional places, where a man would not be constantly working, that such figures were met. There *were* places, however, where you could hold your lamp at arm's length and be unable to see it!

The Development of Lighting Fittings

At the eighth meeting of the I.E.S. Huddersfield Group, on April 10, an interesting address was given by Mr. S. C. McDiaimid on the development of lighting fittings. The lecturer made the audience realise that the days of haphazard lighting by just hanging an electric lamp where it is required are gone. The development of lighting fittings is now a very serious art; although some of the best designs may look quite simple, they actually involve a very considerable amount of work put in by the designer, who must bear in mind the practical considerations of manufacture, installation, and operation, and must also be able to obtain the most satisfactory optical results. The most suitable materials to be used for reflectors have to be considered, amongst which the more important are anodised aluminium, chromium, rhodium, silver plate, vitreous enamel, mirror glass, and nickel. Some of these have surfaces resistant to corrosion and are capable of taking a high polish. In particular, rhodium and chromium are good in this respect. Mirror glass has, of course, very high reflectivity, but its use in lighting fittings introduces complications especially when high wattage lamps are to be used and the heat is considerable. Some of the most popular materials in use are anodised aluminium and vitreous enamel, the latter being most popular for industrial reflectors. It is capable of withstanding high temperatures, it is very easily cleaned, is cheap to manufacture, and has a reflection factor up to 70 or 80 per cent. The lecturer also dealt with refraction of light, showing by means of polar diagrams how the distribution of light may be controlled and altered. A hearty vote of thanks was proposed by Mr. R. Hardy. In the unavoidable absence of Dr. Whitaker (chairman) and Mr. E. Lunn (vice-chairman), Mr. J. T. Thornton, chairman-elect, presided.

Fatal Road Accidents and the Black-Out

An instructive bulletin (No. 18, October, 1944) is available from the Royal Society for the Prevention of Accidents recording fatal road accidents for the period from September, 1939, to August, 1944. Through the courtesy of the Society we have been furnished with additional figures, bringing the record up to February, 1945, the latest month for which data are at the moment available.

In analysing these data it is natural to concentrate on *adult pedestrians*, the class above all others susceptible to accidents at night. In the case of child pedestrians, who are usually in bed when darkness sets in, the number of accidents during darkness has always been minute compared with those in daylight. The number of accidents to motor drivers and motor cyclists, who carry lights, is relatively small, and they are less at a disadvantage in the darkness.

A study of the statistics brings out the point we have often emphasised—the relatively large number of accidents occurring by night as compared with those by day. Taking first the five years from September, 1939, onwards, for which complete data are available, one notes that for adult pedestrians the average number of deaths per day, during the five years cited, was 2.5, 3.8, 3.0, 2.5, and 2.9 during the daytime; in other words, the rate did not vary much and was almost the same at the end of the period as in the beginning.

During the night period the picture is very different. The corresponding figures were 8.7, 7.3, 5.1, 3.6, and 3.1. In other words, the annual rate in darkness, originally nearly 3½ times the rate in daylight (an astonishing figure considering the relatively small use of the roads by pedestrians during the black-out) ultimately fell to near equality. The study of the totals of accidents for successive years, of course, presents a similar story. During daylight the total for 1939-40 was 916, and except for 1940-41 (when it rose to 1,388) it has remained near this figure. The 1939-40 total for accidents in darkness, on the other hand, was 3,178, and this diminished rapidly in subsequent years until the figure for 1943-44 was 1,222—comparable with that in daylight.

During this period many factors contributed to the decrease. It is to be hoped that the progressive introduction of war-time street lighting helped; so, too, did the introduction of extra "summer time," but the most important factor was no doubt gradual adaptation to the new and strange conditions.

When one considers separately the dark winter months (October to January) the difference between results in daylight and darkness becomes much more pronounced and the progressive diminution even more evident. During subsequent months in 1945 the tendency towards a reduction has been accentuated. Whereas in December, 1939, the accidents in darkness (678) were nearly *ten times* those in daylight (71), and in January, 1940, was just *eight times*, in December, 1944, the accidents in darkness (166) were only 2½ times those in daylight (84).

In January, 1945, the number of accidents, 73, was identical in darkness and in daylight; and finally, in February, 1945, the number in darkness (61) was actually less than in daylight (74).

There seems fair reason for believing that the partial restoration of street lighting has been one of the factors bringing about this recent change. It is true that permission for this improved lighting was given in September last, but some months would be necessary for it to come into general operation. Moreover, there is always a time lag due to the necessity for adaptation to the new conditions. When the brighter lighting was authorised there were even some who predicted an initial and temporary *rise* in accidents. This does not seem to have occurred, but the inclination to take more risks may have slowed down the beneficial effect which only became fully apparent in November, December, and January.

The International System of Colour Specification

The fifth Annual General Meeting of the Colour Group was held at the Imperial College of Science on Wednesday, March 21, before the joint meeting of the Illuminating Engineering Society and the Royal Meteorological Society. At this meeting a report on the activities of the Group during the past year was presented. This showed that the membership of the Group was practically unchanged, and that reports were nearing completion on the subjects of "Colour Vision Deficiency in Industry" and on "Colour Terminology." In collaboration with Messrs. Kodak Ltd. the Group has in hand the production of a film on colorimetry.

Dr. R. K. Schofield was elected Chairman of the Committee of the Group. Dr. W. D. Wright remains Hon. Secretary.

This purely business meeting was followed immediately by a science meeting, at which the new Chairman, Dr. Schofield, gave a paper on "The Presentation of the C.I.E. System of Colour Specification." The chair was taken by Mr. J. Guild.

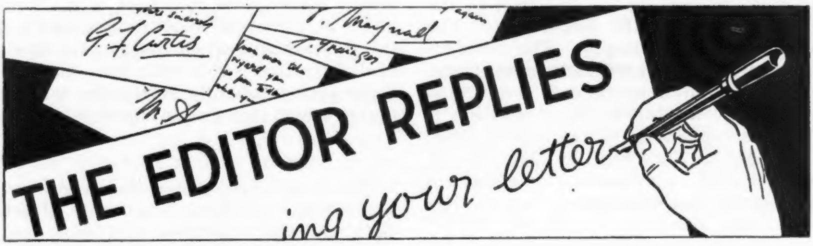
Dr. Schofield began his remarks with a brief historical survey of the C.I.E. system of colour specification. This was adopted by the International Commission on Illumination in 1931, and it was based principally on the experimental work of Guild and Wright and their co-workers, so far as the chromaticity data was concerned, and on the work of Davis and Gibson in America so far as the standard illuminants were concerned. Dr. Schofield said he felt very strongly that the C.I.E. system was not as widely used, or even understood, as it should be, and in his opinion this was due, at least in part, to the manner in which the system was presented. The triangular plot of the trichromatic coefficients was convenient for many purposes, but the system was simpler to understand if approached through the tristimulus values. These could be plotted in a solid (three-dimensional) diagram with mutually perpendicular axes for X, Y, and Z. On this plot greys were on a sloping line, and it was possible to build up a colour "solid" analogous to the colour solids of the Munsell and Ostwald systems. Certain fundamental properties of surface colours would be at once exhibited by means of this solid, but were not apparent from the triangular plot.

The lecture was followed by a discussion, in which several speakers expressed the view that it had taken them some time to become familiar with the C.I.E. system as generally presented, and they hinted at some reluctance to embark on a re-presentation of it on a different basis. Some questions were raised which were not strictly relevant to the subject; for example, the extent to which the standard illuminants A, B, and C were used here and in America. In some concluding remarks the chairman emphasised that there was no warrant for using the letters X, Y, and Z to represent numerical values, and the recent tendency in this direction (generally in the U.S.A.) was a negation of the international agreement of 1931.

The Lighting of Automobiles and Public Service Vehicles

In a paper on this subject, read before the Institution of Automobile Engineers on March 6, Mr. W. H. Lund undertook an analysis of beams from automobile headlights, discussing the dazzling effect and explaining the misconceptions of designers of "non-dazzle" headlamps, some of whom concentrated on the top of half of the apparatus and others on the lower half —both reaching only a partial solution.

After referring to such familiar expedients as "dipped headlamps," "passing beams," etc., and to methods of achieving "flat beam" projection, Mr. Lund suggested three possible future systems intended respectively for slow-running vehicles, average cars, and high-power fast cars, and presented the skeleton of a possible standard headlamp specification chart. Reviewing future developments, he noted the possibilities of the "sealed beam" system, almost universal in America, and alluded to the possibility that mercury vapour electric discharge headlamps might ultimately come into use. Systems based on polarised light have evident drawbacks at present, e.g., they would certainly involve considerably greater power. In regard to fog he made the interesting suggestion, based on the fact that fog usually thins out near the ground, of an emergency low-level perfectly flat horizontal beam. For the internal lighting of trams and trolley buses fluorescent tubes seem attractive; but it must be remembered that they require an operating a.c. voltage of not less than 110-120, and also a stabilising device.



I have been asked for guidance in regard to **the desirable ratio** between the actual **working illumination** and the **illumination of the surroundings**—a point that requires consideration chiefly when general lighting is supplemented by high local illumination. Theoretically the desirable ratio depends to some extent on the order of illumination. In most cases, however, it is recommended that the surrounding general illumination should not be less than *one-tenth,* and preferably not less than *one-fifth,* of the high local illumination on the work.

Yet here again much depends on local conditions. Quite a considerable change may be endured by the eye provided the transition is *gradual* and not abrupt. A light colour for the surroundings is obviously a very material advantage. and much light is scattered by reflection in all installations. Indeed the writer is inclined to doubt whether a really disagreeable contrast will ever ensue provided the surroundings are reasonably light in colour. In adjudicating this matter one must not think only of factories. In dwellings and places of entertainment quite other considerations may arise, so that one should not be dogmatic in laying down hard and fast rules for all spheres of lighting.

The point made above—that the eye may fail to perceive very large variations in brightness, provided they occur gradually, and yet suffers when it experiences the results—is well illustrated by **the consideration of shadows.** So gradual are the changes in brightness occasioned by shadows of highly diffused sources that many people speak of them as "shadowless." There is, of course, **no such thing as a shadowless source.** If one's head is bent over the task the illumination from above may be materially blocked and the actual illumination working diminished—even though the worker is unconscious of shadow.

I have been asked whether the present **legislation in regard to factory lighting** is to be regarded as permanent. The position is a little obscure. We have, superimposed over the regulations based on the Departmental Committee's "Fifth" Report, the Factories (Standards of Lighting) Regulations, 1941, which apply strictly only to factories in which persons are employed for more than 48 hours per week. This Order will presumably continue in operation until it is rescinded or replaced. It seems to me improbable, however, that there can be any substantial reduction in the standards to which workers have become accustomed during the war and that the conditions in the Fifth Report, with its minimum working illumination of 6 ft.c., at least will continue to apply.

I have been occasionally asked to verify the word "**insolation,**" introduced

to many readers for the first time by the issue of the D.S.I.R. Report on "The Lighting of Buildings." The term is used in connection with entrance of sunlight into buildings (and is not a misprint for "insulation" or "isolation"). The last appendix, in the report cited, contains an account by Mr. P. V. Burnett of a proposed method of measuring this quantity.

It has been suggested that the report places rather faint emphasis on the value of **entrance of sunlight,** which, **from the health standpoint,** is presumably based largely on its germicidal properties. (Direct entrance of sunlight during working hours is, in the writer's experience, usually a definite nuisance.) It may be noted, however, that according to Garrod even diffused daylight is also valuable in this respect (*Light and Lighting*, April, 1944, p. 62). This adds weight to the case of those who attach importance to **the desirability of windows** in buildings (occasionally disputed by enthusiasts for artificial lighting).

I like best, however, the argument that windows serve not only to *let light in* but to enable *the eye to look out*. In general they contribute very considerably to the charm of interiors—and it can only be under very unfortunate circumstances that they become aesthetically of little value.

In connection with the natural lighting of interiors it has often been pointed out **the eye tends to underestimate** the **enormous variations** in the values of illumination as one steps back from the window—at least during periods of full daylight when the general level of illumination is high. It is, however, surely erroneous to draw the inference that such variations do not greatly matter and that the daylight factor may be ignored. For the fact remains that where the illumination is only 1-10th or 1-100th or less of the full value the eye's capacity is correspondingly diminished, even though the observer may not be conscious of it. The effect is, of course, most pronounced on the dullest days when the general level of illumination is relatively low—such as occur very frequently during the winter, and of which due account must be taken.

The same phenomenon has even been pointed out in connection with **street lighting.** Here the level of illumination is low, and visibility (so far as it depends on illumination rather than road brightness) must be seriously diminished at values only 1-50th or less of the maximum. Yet, provided the gradation is gradual, quite wide variations may well escape notice . Admittedly the effects of diminution in illumination and brightness are even more important when they occur suddenly.

I have been delighted to receive a letter from Mr. A. P. Trotter, now approaching 88 years of age, but still a keen reader of this journal, who follows with interest developments in lamps and photometry. In the heart of Wiltshire the problems of street lighting are readily solved—there isn't any—and fluorescent lamps are naturally not in evidence. But it must be interesting to Mr. Trotter to observe that the old problems—including the preparation of the ideal street lighting specification in which he took such an active part more than 30 years ago—are still with us.

Lighting: The Industrial Engineer's Point of View

The excellent series of meetings organised by the I.E.S. Nottingham Centre, expressing in turn the view-points of various experts on lighting, included one on March 2 by Mr. W. Imrie Smith voicing the outlook of the industrial lighting engineer.

The author emphasised very strongly the need for analysis of industrial lighting problems. The form taken by the final installation should be built upon a careful study of the processes for which it is intended. There may be some inclination in present circumstances to adopt facile solutions. Mr. Imrie Smith illustrated his remarks by numerous lantern slides and pointed out the vast field for future development. Experience under daylight conditions by no means represents the limit of possible achievements. There was a keen discussion. Mr. Hacking, in moving the vote of thanks, expressed appreciation of the instructive approach to the subject taken by the lecturer, which he described as real illuminating engineering—as opposed to the practice of "pouring lumens into a building" merely to obtain so many foot-candles.

Annual Essay Competition

I.E.S. Birmingham Centre

It has been announced that the prizes won in the Annual Essay Competition, organised by the I.E.S. Birmingham Centre for technical schools in the Midland Area, were presented by the President on the occasion of his recent visit.

The subject of the competition this year was "Street Lighting—its Effect on Civilisation." A good number of entries were again received, the prize-winners being F. W. Higgins (of Queen Mary's Grammar School, Walsall) and R. V. Roberts (Willenhall Technical School), with L. G. Robinson (Wednesbury Technical School) highly commended. Free student membership in the I.E.S. will be given to the prize-winners for one year.

This essay competition has now been organised for several successive years and must have been the means of introducing a considerable number of pupils at technical schools in the Midland Area to illuminating engineering. Other Centres might well explore this idea.

"Light in Daily Life"*

The above little book, like many others, has suffered from the vicissitudes of war, and has been for some time unobtainable. The last remains of the stock were utilised as prizes in one of the competitions for local school children organised by the I.E.S. Birmingham Centre.

It is now announced, however, that a further supply is available and that the book can be supplied on request.

It may be recalled that "Light in Daily Life," as its title implies, deals in a readable manner with modern lighting problems. Amongst the topics discussed are "Light and Civilisation," "The Lighting of the King's Highway," "Light and Transport," "Light and Work," "Light: the Salesman," "Light in the Home," "Light and Entertainment," and "Light in Time to Come."

Lighting Data Sheets

A very useful supplement to the records of its proceedings is the series of "Lighting Data Sheets," issued periodically by the American Illuminating Engineering Society. By a new arrangement, just initiated, these sheets are being issued to all members of that body (accompanied by a subscription form which enables them or their friends to apply for extra copies). The series before us comprises six sheets. Five of these deal with interior lighting (e.g., in offices, automobile repair shops, camouflage spray buildings, and a "B blimp hangar"). The sixth deals with underwater lighting for the detection of leaks.

REVIEWS OF BOOKS

The Gas Journal Calendar and Directory. (*Walter King, Ltd. London.* 1945.)

Once more this familiar publication appears. The directory, occupying 144 pages, gives particulars of gas undertakings in the United Kingdom and Eire, and also in Australia, Canada, and New Zealand, etc. A valuable feature, on which we have commented in previous years, is the list of public lighting engineers. The handbook, occupying approximately 100 pages, contains the usual series of technical contributions dealing with gas engineering, together with useful information and tables and a bibliography.

* "Light in Daily Life," by J. Stewart Dow. Obtainable from The Illuminating Engineering Publishing Company, Ltd., 32, Victoria Street, London, S.W.1.; 4s. 6d., post free 4s. 10d.

Polarised Light

The I.E.S. Tees-side Group stepped out of the ordinary orbit of illuminating engineering for their final meeting on March 21, when Mr. T. I. Pickering gave a talk on Polarised Light, referring specially to its possible application for preventing dazzle by motor headlights. Mr. Pickering introduced his subject by some discussion of the theory of light, the nature of polarisation, and the action of doubly refracting materials such as Iceland spar. The quality of furnishing light vibrating in one plane only is possessed by "polaroid," "nylon," and similar synthetic materials, but the loss of light involved, variously estimated at from 40 to 80 per cent., is substantial. Mr. Pickering explained how screens of such material might be applied to reduce the dazzle from automobile headlights in the future, cars being fitted with windscreens of the polarising material and headlights with plates having a similar effect. Both are set at an angle of 45° to the road surface. When cars so equipped approach each other neither driver can see the opposing headlight as the polarisers are "crossed," but side lights and illuminated objects are still visible. There are other applications of polarising sheets, as yet in process of development which may well prove practical possibilities in the future. Amongst these may be recalled the production of stereoscopic vision in films, and the elimination in glare, owing to reflected light, through windows. It is no bad thing to have occasional papers on special subjects such as this. Illuminating engineers should take a broad interest in all processes in which light is concerned.